

Original Research Paper

Less invasive treatment for delayed or nonunion: The use of percutaneous autologous bone marrow injection

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Abstract

Fracture heals by advanced vital process in which bone regenerates by restoring the integrity of skeletal tissue. In non-union fracture healing cascade has ceased and it'll not progress while not intervention. Autologous bone marrow grafts are regarded as vital material for treating non-unions. Recently there has been a trend towards a lesser invasive technique in which bone marrow graft i.e. autologous in nature, is taken from iliac bone by aspiration needle and is administered percutaneously at non union site.

Material and Methods:

30 cases of post-traumatic delayed and non-union of fracture tibia with internal fixation or fractures more than 12 weeks with abnormal mobility without infection were included in the study. Baseline RUST scoring was calculated for each fracture and bone marrow aspirate injections were given at fracture site by percutaneous route.

Result:

On the premise of final RUST scores at half dozen months and clinical analysis, union of 23(76.67%) fractures were achieved by autologous bone marrow injections by percutaneous route whereas 7(23.33%) cases were failed even after three attempts of procedure. The complications of the procedure are negligible and is safe. The mean time of radiological union in our study was fourteen weeks with a spread of 11-22 weeks.

Conclusion:

On the premise of our results and observations within the study we are able to conclude that regional autologous bone marrow injection is an efficient method compared to traditional open bone grafting with less invasive technique, will be performed as out-patient procedure underneath local anesthesia, cheap and safe with negligible complication rate at donor or recipient graft site.

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Introduction

Fracture heals by advanced vital process in which bone regenerates by restoring the integrity of skeletal tissue. Healing could be primary or secondary relying upon the rigidity of fixation with most fractures exhibiting each sorts of healing. The time within which a fracture can unite varies in keeping with age, species, bone concerned with type of fracture pattern and accompanying soft tissue destruction and associated general illness. Delayed union and non-union are the common issues that any orthopaedician might face addressing fracture healing common in treatment of long bones particularly tibia. Causes of non-union is also native, general or mechanical like bone loss, infection, smoking, malreduction etc. Impaired fracture healing is predicted to occur in 5-10% of all fractures and also the incidence nearly double just in case of open fractures and fractures with soft tissue injury. Incidence of Non-unions are projected to be two percent to fifteen percent of all tibia fractures. They account for thirty fifth to sixty fifth of all non-union.

In non-union fracture healing cascade has ceased and it'll not progress while not intervention. Autologous bone marrow grafts are regarded as vital material for treating non-unions to provide 3 very important elements for healing that square measure osteoconductivity, osteoinductivity and osteogenic potential. Open bone marrow graft involves an extra surgical intervention which can be related to donor graft site morbidity. Recently there has been a trend towards a lesser invasive technique in which bone marrow graft i.e autologous in nature, is administered percutaneously. The marrow that is taken from iliac bone by aspiration needle in natural kind with none separation of the contents and so injected at the fracture site with the guidance of C-Arm, by percutaneous technique, contains each kinds of cells i.e. induced to produce bone and itself



Fig.1 PERCUTANEOUS INJECTION OF AUTOLOGOUS BONE MARROW

consolidate to form bone. This methodology has certain benefits like no surgical exploration of both the donor and recipient graft site.

Hence, to verify the efficiency of bone marrow graft injections in the treatment of delayed unions and non-unions, the present study is conducted.(Fig.1).

Material And Methodology

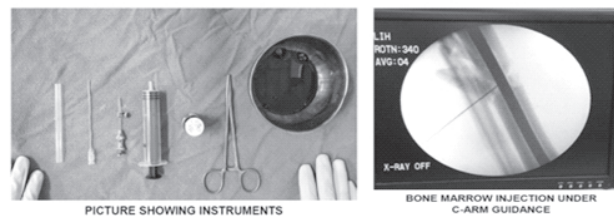
The study was prospective in nature in which 30 cases of post traumatic non-union and delayed union of fracture leg bone attending orthopaedics department Govt. Medical college and Hospital, Patiala were taken. Duration of study was from July 2016 to July 2018 with mixed sample size irrespective of their age and sex and devoid of infection. Patients with internal fixation or fractures over twelve weeks with unnatural movements at the fracture site were included in the study. X-rays of the affected bone were thoroughly evaluated for signs of nonunion or delayed union like gap, quantity of callus and sclerosis and classified consequently. Baseline RUST marking was calculated for every fracture.

Operative Technique:

This procedure can be performed on day care basis under local or short general anesthesia:

- Position of patients were placed in supine.
- Under all aseptic conditions donor and recipient sites were painted and draped separately at the same time.
- About 2-3mm of incision was made over the iliac bone crest and Needle was inserted at the multiple areas of posterior bone crest to aspirate the bone marrow. Bone marrow aspiration needle was connected to a twenty cubic centimetre syringe. Heparinisation was done to avoid clotting. About 10-15ml of marrow was aspirated from one site and multiple aspirates were done with minimum of 40-150ml of bone marrow was harvested.
- Under C-Arm micro trauma was created employing a needle at non-union site and the aspirated marrow was injected by percutaneously route at the recipient fracture site by sixteen-gauge spinal needle. (Fig 2)

Figure 2:



POP slab or of braces were given after the bone marrow injection to immobilize the recipient graft site. Aseptic dressing done at donor site. Then the patients were evaluated at 4-6 weeks intervals. Injections were re-administered at 4-6 weeks if there was no imaging proof of callus formation seen. The procedure was thought of a failure if there was no clinical and imaging union at half dozen weeks following the third injection. Follow up was done at monthly interval for 3 months then at 6th month following the bone marrow injection. Patients were evaluated both clinically and radiologically at the follow ups. (Table No.1).

Table 1:

Score per Cortex	Callus	Fracture line
1	Absent	Visible
2	Present	Visible
3	Present	Invisible

Table No.1-Radiographic Union Scale in Tibial Fracture (RUST)

As per RUST score:

- * Each leg bone cortex was given score of one
- * Cortex with an apparent line and no callus was given a score of one,
- * Cortex wherever callus and a visible fracture line, was assigned score of two and
- * Cortex with a bridging callus and no fracture line was scored as three.

Then addition of all cortices score is done to convey a minimum score of 4(definitely not healed) and a most of twelve (completely healed). Radiologically, union was confirmed if there was a bridging callus on a minimum of 3 cortices on radiographs in 2 planes or an accumulative RUST score of nine. Clinically there would be no pain, no tenderness without any abnormal movements at the fracture site and quantum of callus is appreciable without any gap at the fracture site on X-Rays.

Observations:

On the premise of RUST scores at half dozen months and clinical analysis 23(76.67%) fractures united whereas 7(23.33%) unsuccessful. Nine patients needed one injection for union, eleven patients needed two injections for union and three patients needed 3 injections for union. Of the seven patients that failed to recovered all got three bone marrow injections. All the unsuccessful cases received three injections. (Table 2)

	No. Of Patients	Percentage
Union Achieved	23	76.67
Failures	7	23.33

After analysis on the premise of imaging and clinical criteria no case achieved union at four weeks, 1(3.33%) case was united at eight Weeks, 11(36.67%) cases were united at twelve weeks and 23(76.67%) cases were united at twenty-three weeks (Table 3).

Time for Radiological Union	Patients with Union	Percentage
At 4 weeks	0	0
At 8 weeks	1	3.33
At 12 weeks	11	36.67
At 6 months	23	76.67

The mean time of imaging union after bone marrow injection in our study was fourteen weeks with a spread of 11-22 weeks. The mean RUST score before procedure was 4.63. Elevated to 5.2 at four weeks, 6.36 at eight weeks, 7.56 at twelve weeks and 9.37 at half dozen months. Out of total thirty patients who have undergone the procedure 5(16.67%) patients complaint donor site pain for few days that was treated with oral analgesics. No alternative major or minor complication was noted.

Discussion

Bone marrow injections which were autologous in nature were administered in 30 cases of delayed union and non-union without any infection. The range of age was 21 to 62 years with a mean age of 41.3 years. The lesser number of patients within the younger cohort is also thanks to better bone healing potential within the younger patients. The number of males within the study were more than females with a p value of 0.023. There have been sixteen right sided fractures and fourteen left sided fractures. 22(73%) patient suffered trauma because of road side accident whereas 8(27%) had a history of fall. The failure rates were found to be considerably higher in RSA patients with a p-value of 0.001 typically due to high energy trauma resulting in complicated fracture patterns with complex injury to regional soft tissues. Of the whole thirty cases of impaired union 3(10%) affected proximal shinbone, 11(37%) affected middle one third of shinbone and 16(53%) affected lower one third of shinbone. It might be result of distal one third leg bone fractures area unit typically related to a high complication rate together with non-union. 20(66.67%) fractures were classified as delayed unions and 10(33.33%) fractures as non-unions.

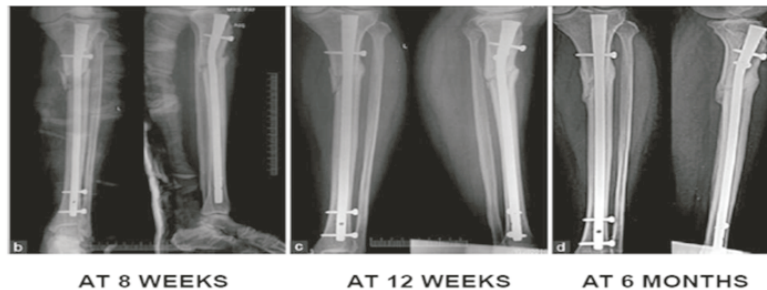
In the study 12(40%) were at first treated with plating whereas 18(60%) cases were at first treated with interlocking nail tibia. The Average time of bone marrow injections since injury was 21.67 ± 9.69 weeks with a spread from 12-38 weeks. The average time of union after procedure was fourteen weeks with a spread of 11-22 weeks that is comparable Singh et al 2004, padha et al.2005, Bhutia et al 2012 and Sahu et al 2018. In current study failure rate was higher in non-union cluster than delayed union. This could be result of the less quantity of biological activity at the fracture site inside this cluster than delayed union cluster. Similar results are seen in previous studies as shown in Bhargava et al. Few patients (six out of 28) complained of mild ache at the donor site, that subsides in 2 to a few weeks with support and analgesics. The share of eminent union was considerably less within the smoking cluster as compared to non-smokers with p- price of 0.01. Sahu et al.

reported an extended time to union in patients with smoking but their observation couldn't reach to applied math significance. Similar trends are seen within the study conducted by Elsattar et al. in year 2009. The negative impact of smoking on bone healing is well valid in previous studies.

Average times of union and average range of injections were compared among other age sets. The average time of union was higher in age cohort 41-60 than in cohort 21-60. However, the observation couldn't reach to mathematical significance and contains a p-value of 0.174. The average number of injections were highest in age cohort more than sixty years followed by cohort 41-60 and least in cohort between 21-40. The observation is statistically vital with a p value of 0.004. Similarly, the mean RUST scores before procedure and at half dozen months were higher in younger age groups and show a decreasing trend with the progression older. The distinction in average rust scores among various age sets at half dozen months from procedure was found to be statistically vital with a p value of 0.001. The trend seen with previous four variables in comparison among completely different age sets is also jointly attributed to effects of aging on the bone healing.

On the premise of final RUST scores at half dozen months and clinical analysis, union of 23(76.67%) fractures were achieved by autologous bone marrow injections by percutaneous route whereas 7(23.33%) cases were failed even after three attempts of procedure. The complications of the procedure are negligible and is cost effective and safe. The mean time of radiological union in our study was fourteen weeks with a spread of 11-22 weeks. (Fig 3)

PROGRESS OF UNION AFTER PERCUTANEOUS AUTOLOGOUS BONE MARROW INJECTION



Conclusion

On the premise of our results and observations within the study we are able to conclude that regional autologous bone marrow injection is an efficient method compared to traditional open bone grafting with less invasive technique, will be performed as out-patient procedure underneath local anesthesia, cheap and safe with negligible complication rate at donor or recipient graft site.

Limitations Of Study

The limitations of our study area unit were a small sample size and no control cluster. Further analysis is needed to ascertain smoking as a contributor to non-union and its result on healing once it's eliminated in patients with recent fractures or established non-union.

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Ethical committee approval: Taken

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